

**APPENDIX C**  
**COUPON DPM PROCESS DOCUMENTATION**

Symbology Research Center

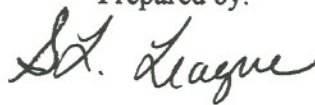
SRC-RPT-01-001

**USAF Aging Landing Gear Life Extension Program  
Marking Test Report**

General Atomics Purchase Order Number H033303

March 29, 2001

Prepared by:




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Huntsville, Alabama 35805


**RVSI**  
**Acuity CiMatrix**

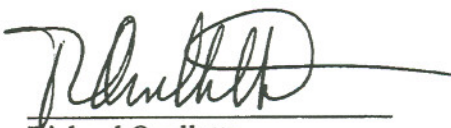
**USAF Aging Landing Gear Life Extension Program  
Marking Test Report**

March 29, 2001

Approved by:

  
Donald L. Roxby  
Director, Symbology Research Center  
RVSI Acuity CiMatrix

  
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RVSI Acuity CiMatrix

  
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COO  
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## Preface

The marking methods currently approved for use on Department of Defense (DOD) programs/projects were developed to apply human readable markings to larger size structures, mechanical component, and piece parts. While these marking methods have proven to be adequate for this purpose, they generally do not provide the fidelity need to apply machine-readable symbols, and often fail to remain readable after being subjected to overhaul processes. Recognizing these problems, and being faced with the same part traceability issues, the National Aeronautics and Space Administration (NASA) undertook the task of identifying new direct part marking (DPM) techniques designed specifically for the application of 2-D symbols to aerospace materials. During this program, NASA successfully demonstrated that 2-D symbols applied using DPM methods and techniques were safe for use in the aerospace applications if applied correctly. These DPM methods and subsequent methods and techniques identified by RVSI, however, have not undergone testing to ensure that they will remain readable after being subjected to landing gear overhaul processes. The United States Air Force Landing Gear Engineering Division at Ogden Air Logistics Center (OO-ALC/LILE) decided to evaluate the survivability of marks applied with DPM process through normal landing gear overhaul conditions (NALGPOC). This DPM Evaluation was conducted under the Aging Landing Gear Life Extension (ALGLE) Program.

This report includes: the requirements for the test program (Appendix A), parameters used to apply and read the markings (Appendix B), photographs of the various marking types applied to the USAF test coupons (Appendix C) and, copies of all previous non-proprietary 2-D marking tests reports that the RVSI SRC was able to locate (Appendix D).



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## **1.0 INTRODUCTION**

This test report summarizes the results of the marking application portions of the USAF ALGLE Program Direct Part Marking (DPM) Evaluation. The work was accomplished by RVSI's Symbology Research Center (SRC) in response to General Atomics Purchase Order Number H033303. The statement of work and the direct part marking program requirements are contained in Appendix A.

## **2.0 PURPOSE**

The purpose of the marking project was to apply Data Matrix symbols to representative landing gear materials using direct part marking (DPM) processes. The ALGLE Program provided test coupons to the SRC for marking. The SRC marked the test coupons. The SRC also performed decoding checks for the marks on the test coupons. The SRC then delivered the test coupons to the ALGLE Program. The ALGLE Program will continue the DPM Evaluation through microscopic examination of the coupons and through processing the coupons through NALGPOC. All of the markings were applied using methods and techniques defined in the following government documents:

- NASA-STD-6002 (P026), Final Draft - Standard for Applying Data Matrix Identification Symbols on Aerospace Parts
- NASA-HDBK-6003 (P027), Final Draft – Application of Data Matrix Identification Symbols to Aerospace Parts Using Direct Part Marking Methods/Techniques

The SRC will also provide the ALGLE Program samples of new marking processes that are currently under development. These processes are investment casting, sand casting, and plasma spray. The processes are described in paragraphs 4.9, 4.10, and 4.11.

## **3.0 APPROACH**

SRC engineers applied test markings to practice coupons made of two different material types (4340 per AMS 6415 and AL 7075-T7351 per AMS 4078) to determine the optimal settings required to apply easily decodable symbols. Easily decodable symbols were considered AIM mark quality grade of B or greater. The optimum marks were determined by adjusting machine parameters to produce marks over a wide range of power settings. From this set of markings, the

mark that was easily decoded and received the overall best AIM mark quality grade was chosen as the optimum mark. Finished markings were then applied to test coupons using eight different DPM processes: 1) Dot Peening, 2) LaserShot Peening™, 3) Micro-milling, 4) Laser Bonding, 5) Laser Etching, 6) Laser Engraving, 7) Gas Assisted laser Etch (GALE) and, 8) Laser Induced Surface Improvement (LISI). Marking and reading parameters associated with the above tasks are recorded on data sheets contained in Appendix B. Photographs of the various markings are included in Appendix C.

## **4.0 MARKING SYSTEM DESCRIPTIONS**

### **4.1 Dot Peen**

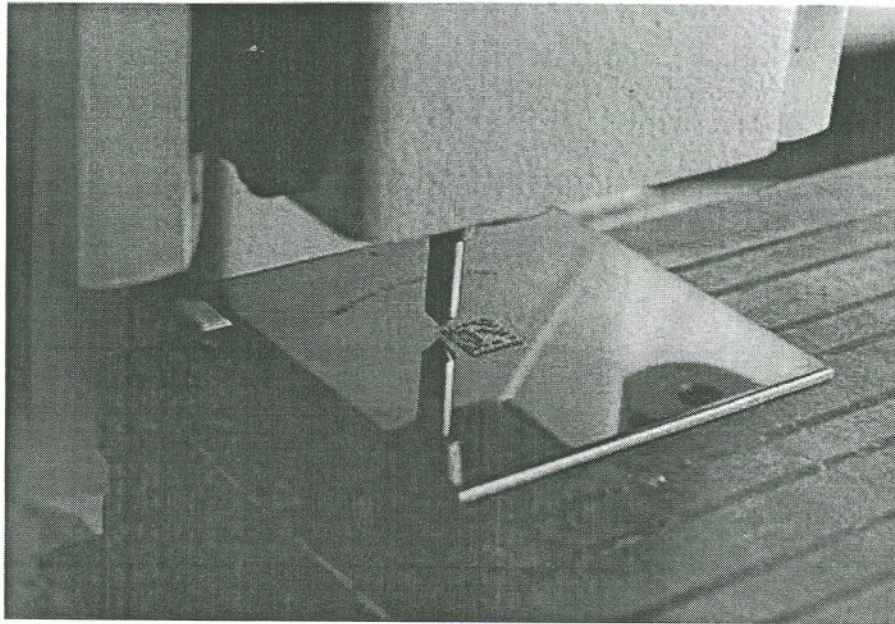
Dot peening is achieved by striking a carbide or diamond tipped marker stylus against the surface of the material being marked. Symbol size is controlled by the size and tip angle of the stylus, dot spacing, or by altering the number of strikes per data cell. Single strikes are used to create small symbols. Multiple strikes may be used to create larger symbols. An odd number of strikes is recommended to create data cells to ensure that a recess is located in the center of each data cell (e.g., 3x3, 5x5, 7x7, etc.).

Dot peen marking is generally limited to parts exposed to harsh manufacturing, operational, and/or refurbishment conditions. Since many of these conditions change surface properties and/or color, it may be necessary to modify the surface to restore readability. This can be accomplished using a weld cleaner to remove oxides from the surface or by back filling the dot recesses with a removable media of contrasting color, usually dry erase ink or chalk.



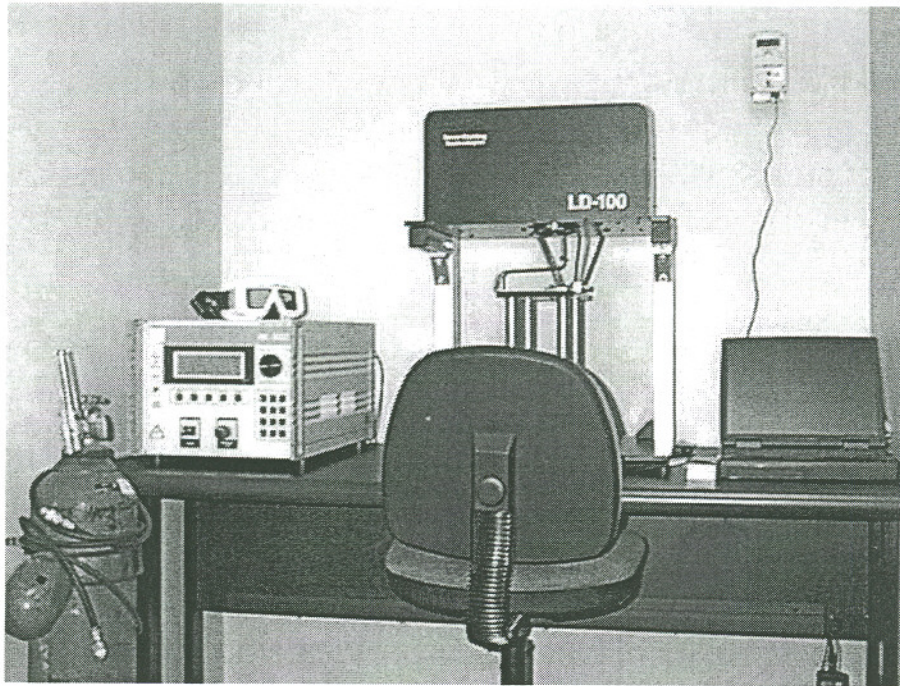


**Figure 1 -Typical Dot Peen Station**



**Figure 2 - Close up of Dot Peen Marking Process**





**Figure 7 – Typical Gas Assisted Laser Etch Marking Station**

**4.8 Laser Induced Surface Improvement (LISI)**

Laser induced surface improvement (LISI) is similar to laser bonding except that the additive material is melted into the metallic host substrate to form an improved alloy with high corrosion resistance and wear properties. LISI is generally used as a surface coating but can be applied directly to parts to form a representation of a symbol. Where required, a LISI patch can be applied that is subsequently marked using another intrusive or non-intrusive marking method. The process is generally used to mark steel parts that rust when exposed to their normal operating environment.

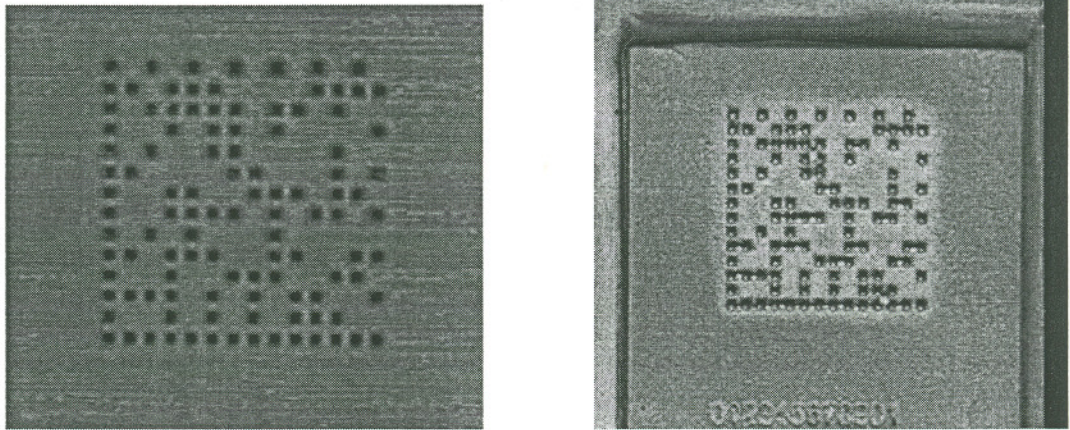
**4.9 Investment Casting**

Cast metal marking of the 2-D Data Matrix identification symbols is achieved by printing a pattern of the Data Matrix symbol in physical or 3-dimensional form on a 3-dimensional printer such as the ThermoJet Solid Object Printer by 3-D Systems. These 3-dimensional printing devices produce physical objects by using an ink jet print head that uses a wax based thermoplastic instead of ink, and prints layer upon layer to build up the “ink” thickness into a 3-dimensional object. For the cast metal marking application the 3-dimensional printed pattern of the Data Matrix symbol is incorporated



into a coupon made from the wax-based thermoplastic material. Once printed this coupon can be turned into a cast metal equivalent by putting the wax coupon pattern through the investment casting process.

For direct part marking of investment cast parts, these wax coupons would be directly attached to the wax pattern of the part to be marked before being put through the investment casting process. For parts that are fabricated using sand casting the wax coupons containing the Data Matrix symbology would be placed into a recess in the mold pattern before the sand mold is compacted and formed. For parts produced by the molding or forged fabrication processes the wax coupons containing the Data Matrix symbology would be investment cast first to produce a cast metal coupon which would be inserted into a recess in the mold before the end use part is fabricated in the mold.



**Figure 8 – Wax Mold and Resulting Investment Casing**

#### 4.10 Sand Casting

Cast metal marking of the 2-D Data Matrix (or other selected symbologies) is achieved by forming a representation of a Data Matrix symbol into a masking material made from a specially formulated millboard material. The stencils are then secured to the sand mold. After the molten metal is poured, the cast part is cooled, and the mask is removed to expose the completed three-dimensional symbology.



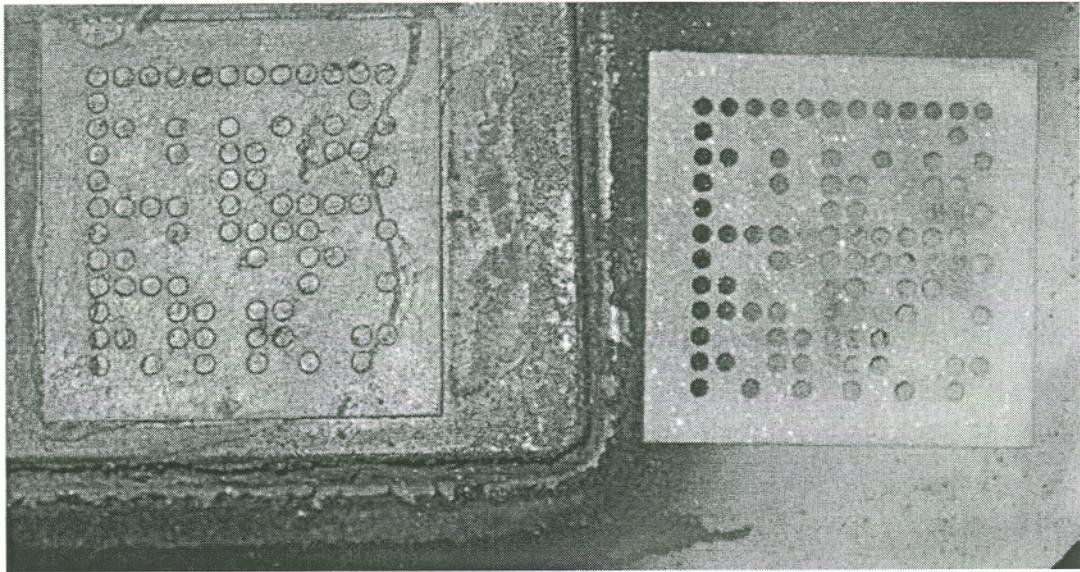
The stencil (mask) insert may be either placed in a recessed cavity in the sand mold or positioned on the surface. Methodologies for securing the stencil insert to avoid back casting and to minimize out-gassing will vary depending on the type of metal. The stencils can be attached to the sand mold using a variety of methods, including, but not limited to, glues, cements, staples, and nails.

The minimum size of the stencil insert is primarily limited by the properties of the metals to be cast and the machining or manufacturing processes to which the casting is subject. However, once the properties of the metals are known, the stencil insert process can be adjusted to achieve the preferred profiles for reading the 2-D Data Matrix symbology.



**Figure 9 – Sand Cast Pouring Operation**





**Figure 10 – Sand Cast Marking and Associated Mask**

#### 4.11 Thermal Spray

Combustion, plasma and wire arc/arc spray devices are being explored as a means to apply metal marking to substrates. This is accomplished by spraying a mist of molten metal to a target covered by a high temperature masking (stencil) material containing openings that correspond to the shape of a symbol. The liquid metal is sprayed over the stencil, which is subsequently removed to expose the symbol.

Thermal spray processes are primarily limited by manufacturing processes as opposed to the materials to be marked. While the metalized spray is high temperature, some of the processes can be applied to surfaces as fragile as a business card without damaging the substrate.

## **5.0 Decoding Tests**

All of the test markings were evaluated for mark quality and decodability. Mark quality was evaluated using RVSI Verifier software. This software is configured to comply with AIM standards for bar code verification. The AIM standard was designed to evaluate high contrast paper labels. Although contrast is critical with 1D bar codes, contrast levels are not a critical measurement for Data Matrix symbols since RVSI readers are equally capable of reading Data Matrix symbols with contrasts as low as 20% (D grade by AIM standard). All marks applied to the USAF coupons received an "A" grade with the exception of a few applied to the darker heat-treated steel coupons. The lowest grade in this category was a "C". The decoding tests were conducted using both fixed station and handheld readers under a variety of different lighting conditions, i.e., total darkness to 2,000 candlepower. Handheld tests were conducted with the reader positioned at  $90 \text{ degrees} \pm 10 \text{ degrees}$  to simulate conditions typically seen in field use.

## **6.0 Summary**

The marking portion of the USAF ALGLE Program DPM Evaluation was successfully completed on March 28, 2001. All of the markings produced were of high quality and decoded without difficulty using RVSI fixed station and MXi hand-held readers. The marked coupons were shipped to Hill AFB for testing on March 30, 2001. The SRC is continually developing new marking processes for industry and forward samples of new marking processes to the USAF as developed.

## **APPENDIX A**

### **PROGRAM REQUIREMENTS**



Aging Landing Gear Life Extension Program  
M-E-39035-112-10000-6 REV C

MEMORANDUM

To: Don Roxby, RVSI  
From: John Coates, MGB  
Date: December 12, 2000  
Subject: Statement of Work for RVSI CI Acuity Matrix, Symbology Research Center  
Marking Coupons for DPM Evaluation

**Background**

Under the ALGLE Program, testing will be conducted for OO-ALC/LILE to evaluate the survivability of marks applied with direct part marking (DPM) processes for normal aircraft landing gear part overhaul conditions (NALGPOC). RVSI was selected to mark the coupons for the evaluation. Because DPM for safety critical aircraft parts is relatively new, RVSI will provide existing, available documentation that demonstrates safe DPM processes. RVSI will assist in determining the optimum DPM process controls that provide marks with no material property degradation and overhaul process survivability. RVSI will mark the coupons for the evaluation. RVSI will thoroughly document the marking processes. If marks pass Microscopy Evaluation I and NALGPOC Survivability I, RVSI may be requested to assist in more optimization work for the marks and the DPM processes.

**Deliver Existing Available Documentation**

1. Deliver existing available test reports, journal articles, or other documentation that demonstrates that marks applied with DPM processes do or do not degrade the material properties of the base metal. The DPM processes under consideration are dot peening, lasershot™ peening, engraving, laser bonding, laser etching, gas assisted laser etching, laser engraving, and laser induced surface improvement.

**Mark and Deliver**

1. Mark Optimization\*
  - 1.1 Determine the optimum DPM process controls for each marking process that provides a mark with no material property degradation and overhaul process survivability. Determine the optimum DPM process controls for each marking process by producing a minimum of six marks using different DPM process controls. To determine the optimum DPM process controls use the coupons listed in Table I.

**Table I: Coupons for Mark Optimization**

Coupon	Serial Number
S1A	-01, -02, -03, -04
S1B	-01, -02, -03, -04
A1A	-01, -02, -03, -04

- 1.2 Use the optimum DPM process controls for each marking process to mark the remaining coupons.
2. Steel Coupons\*
  - 3.1 Mark and deliver coupons S1A-05 to S1A-16 in accordance with drawing S1A REV C requirements.
  - 3.2 Mark and deliver coupons S1B-05 to S1B-16 in accordance with drawing S1B REV C requirements.
  - 3.3 Mark and deliver coupons S2A-01 to S2A-06 in accordance with drawing S2A REV C requirements.
  - 3.4 Mark and deliver coupons S2B-01 to S2B-06 in accordance with drawing S2B REV C requirements.
3. Aluminum Coupons\*
  - 3.1 Mark and deliver coupons A1A-05 to A1A-16 in accordance with drawing A1A REV C requirements.
  - 3.2 Mark and deliver coupons A2A-01 to A2A-06 in accordance with drawing A2A REV C requirements.

\* For each marking process, provide appropriate mark masking to ensure that the marking process does not interfere or damage previously applied marks.

\* RVSI will not mark the coupons with Vibra-Etch.

**Contacts**

MGB: Engineering	Mr. John Coates	Phone: (801) 586-3052
RVSI: Research and Development	Mr. Don Roxby	Phone: (256) 830-8123

Aging Landing Gear Life Extension Program  
M-E-39035-112-10000-6 REV C

**Documentation**

1. Provide documentation for the marking processes.
  - 1.1 A specification and description for each marking process.
    - a. Including critical process controls.
    - b. Including photographs of the marking process equipment.
  - 1.2 Accountability for all marks placed on the coupons for mark optimization.
    - a. Documentation of the process controls for each marking process.
    - b. Mark verification for each mark.
  - 1.3 Accountability for all marks placed on the coupons.
    - a. Documentation of the process controls for each marking process.
    - b. Mark verification for each mark.
  - 1.4 Explanations of any anomalies.
  - 1.5 The documentation will include the DPM Process Data Sheet.

**Handling and Packaging**

1. Coat coupons in light oil between the marking processes and before delivery to prevent corrosion.

**Contacts**

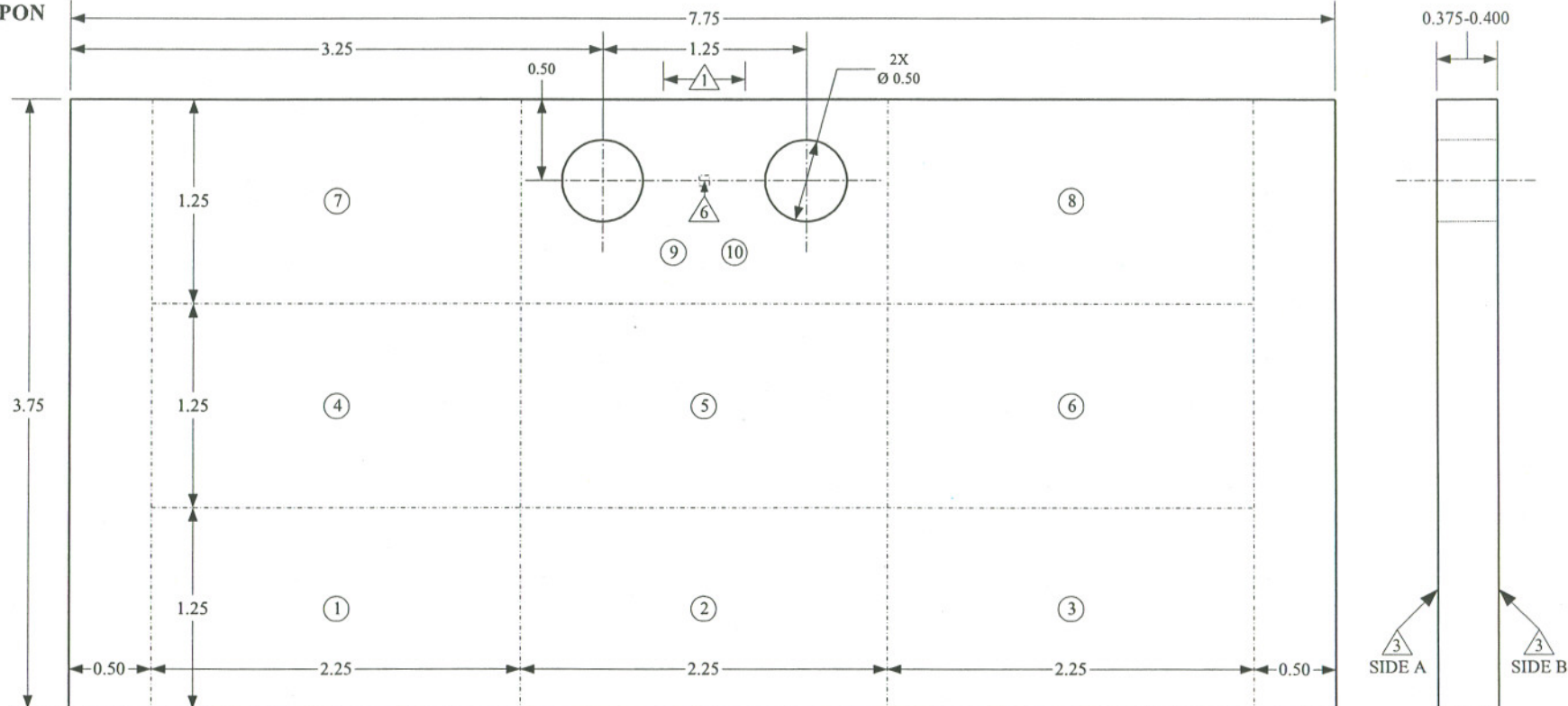
MGB: Engineering  
RVSI: Research and Development

Mr. John Coates  
Mr. Don Roxby

Phone: (801) 586-3052  
Phone: (256) 830-8123




# COUPON



## NOTES

- 1 SERIALIZE THE COUPONS S1A-01 TO S1A-22 ON TOP EDGE AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP
- 2 HEAT TREAT AND PROCESS TO 260-280 KSI ULTIMATE TENSILE STRENGTH PER AMS-H-6875, MAXIMUM ALLOWABLE DECARBURIZATION 0.003
- 3  $0.025 \sqrt{\frac{125}{64} M}$  BEFORE 2,  $\sqrt{\frac{125}{64} M}$  AFTER 2
- 4 BREAK ALL SHARP EDGES 0.005-0.015
- 5 FLUORESCENT MAGNETIC PARTICLE INSPECT PER ASTM E1444
- 6 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM ROCKWELL HARDNESS C TEST PER ASTM A370 AT NOTED LOCATION
- 7 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1
- 1-10 i) FOR COUPONS S1A-01 TO S1A-04: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS  
ii) FOR COUPONS S1A-05 TO S1A-16: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE II REQUIREMENTS

<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S1A	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
						<b>CHECKED</b> FRANK ZUECH

DPM EVALUATION

**MATERIAL** 4340  
PER AMS 6415

**DATE**  
3/9/01

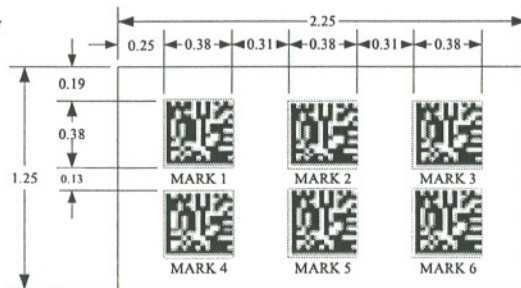
**SHEET**  
1 OF 3

**SCALE**  
NOT TO SCALE

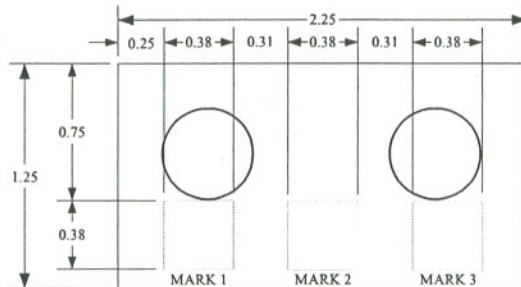
**TABLE I: DATA MATRIX™ OPTIMIZATION**

- ① – ⑩ i) AT LEAST ONE COUPON MUST CONTAIN THE MINIMUM NUMBER OF MARKS  
 ii) FOR THE MINIMUM NUMBER OF MARKS, USE DIFFERENT DPM PROCESS CONTROLS
- ① DOT PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ② LASERSHOT™ PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ③ MICRO-MILL A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ④ LASER BOND A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑤ LASER ETCH A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑥ GAS ASSIST LASER ETCH (GALE) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑦ LASER ENGRAVE A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑨ VIBRA-ETCH A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
  - ⑩ IMPRESSION STAMP A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***




**DETAIL I.B\***



MARK DATA	
①	XXXXXXXXXX
②	XXXXXXXXXX
③	XXXXXXXXXX
④	XXXXXXXXXX
⑤	XXXXXXXXXX
⑥	XXXXXXXXXX
⑦	XXXXXXXXXX
⑧	XXXXXXXXXX
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

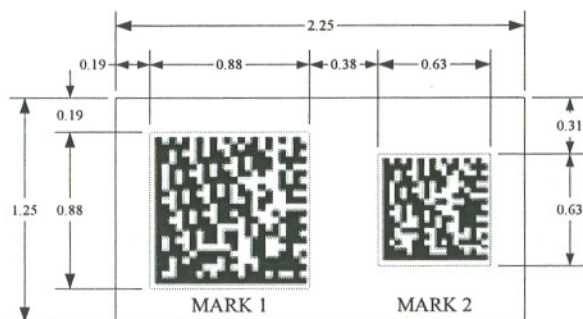
<div>ALGLE PROGRAM</div> <div></div>	TITLE	DRAWING NUMBER	REVISION	DIMENSIONS	TOLERANCES	DRAWN
	COUPON	S1A	C	ALL DIMENSIONS IN INCHES	UNLESS OTHERWISE NOTED	JOHN COATES
	DPM EVALUATION	MATERIAL 4340 PER AMS 6415	DATE 3/9/01	SHEET 2 OF 3	SCALE NOT TO SCALE	X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°



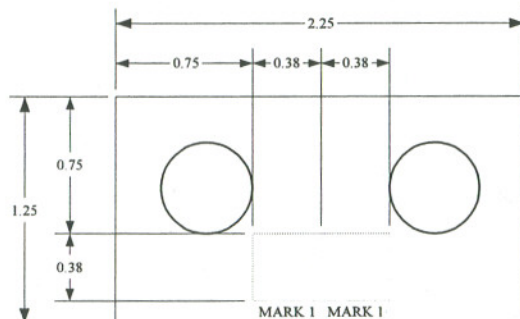
**TABLE II: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL II.A\***




**DETAIL II.B\***

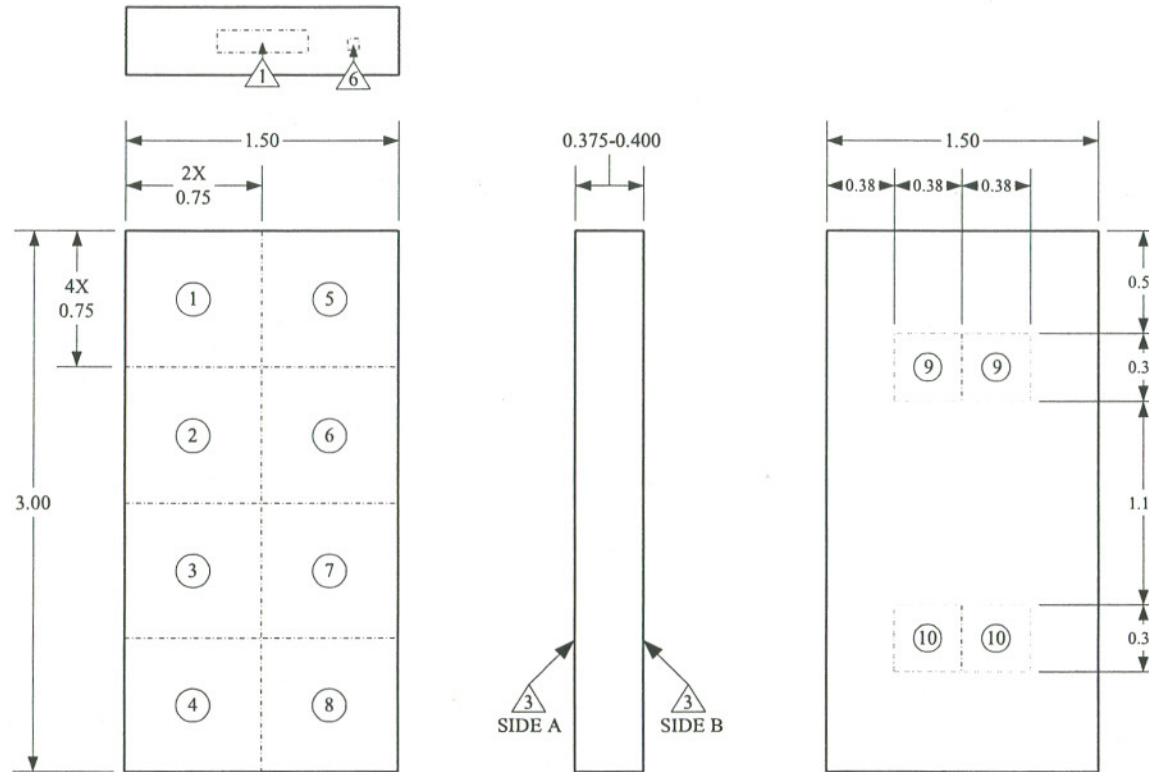


MARK DATA		
	MARK 1 DATA	MARK 2 DATA
①	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX1
②	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX2	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX2
③	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX3
④	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX4
⑤	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX5	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX5
⑥	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX6
⑦	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER	NONE
⑩	ALPHANUMERIC CHARACTER	NONE

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING


<b>ALGLE PROGRAM</b> 	<b>TITLE</b>	<b>DRAWING NUMBER</b>	<b>REVISION</b>	<b>DIMENSIONS</b>	<b>TOLERANCES</b>	<b>DRAWN</b>
	COUPON	S1A	C	ALL DIMENSIONS IN INCHES	UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	JOHN COATES
<b>DPM EVALUATION</b>	MATERIAL 4340 PER AMS 6415	DATE 3/9/01	SHEET 3 OF 3	SCALE NOT TO SCALE		CHECKED FRANK ZUECH

# COUPON



## NOTES

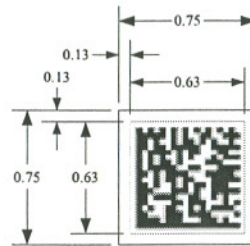
- 1 SERIALIZE THE COUPONS S2A-01 TO S2A-12 AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP
- 2 HEAT TREAT AND PROCESS TO 260-280 KSI ULTIMATE TENSILE STRENGTH PER AMS-H-6875, MAXIMUM ALLOWABLE DECARBURIZATION 0.003
- 3  $0.025 \sqrt{\frac{125}{64}} M$  BEFORE 2,  $\sqrt{\frac{125}{64}} M$  AFTER 2
- 4 BREAK ALL SHARP EDGES 0.005-0.015
- 5 FLUORESCENT MAGNETIC PARTICLE INSPECT PER ASTM E1444
- 6 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM ROCKWELL HARDNESS C TEST PER ASTM A370 AT NOTED LOCATION
- 7 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1
- ① — ⑩ FOR COUPONS S2A-01 TO S2A-06: MARK WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS

ALGLE PROGRAM		TITLE COUPON	DRAWING NUMBER S2A	REVISION C	DIMENSIONS ALL DIMENSIONS IN INCHES	TOLERANCES UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	DRAWN JOHN COATES
DPM EVALUATION		MATERIAL 4340 PER AMS 6415	DATE 3/9/01	SHEET 1 OF 2	SCALE NOT TO SCALE		CHECKED FRANK ZUECH

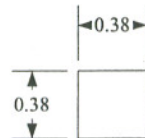
**TABLE I: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***




**DETAIL I.B\***



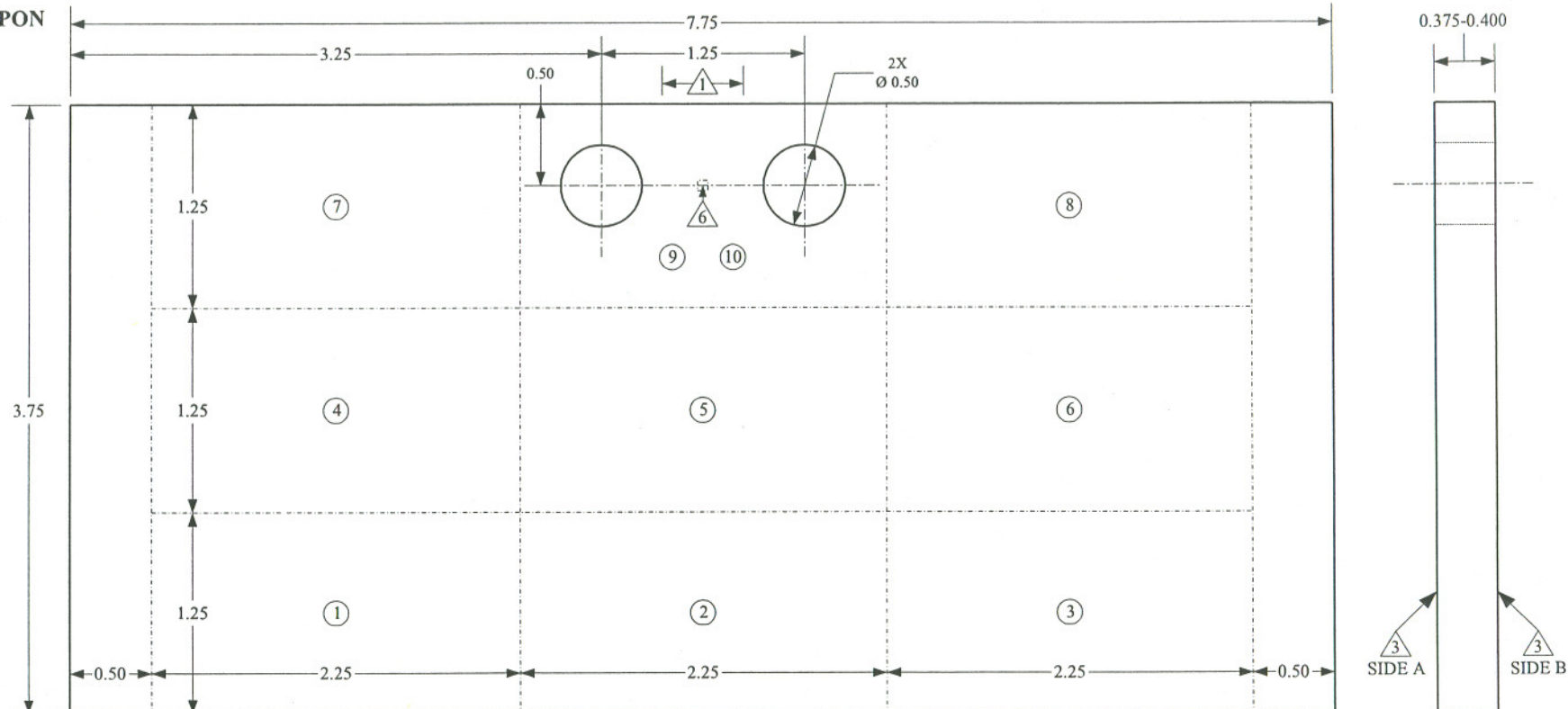
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⑦	XXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S2A	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
	<b>MATERIAL</b> 4340 PER AMS 6415	<b>DATE</b> 3/9/01	<b>SHEET</b> 2 OF 2	<b>SCALE</b> NOT TO SCALE		<b>CHECKED</b> FRANK ZUECH




# COUPON



## NOTES

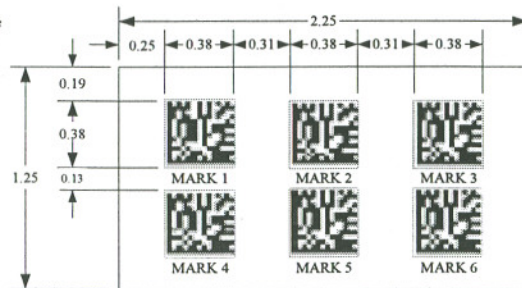
- 1 SERIALIZE THE COUPONS S1B-01 TO S1B-16 ON TOP EDGE AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP
- 2 HEAT TREAT AND PROCESS TO 260-280 KSI ULTIMATE TENSILE STRENGTH PER AMS-H-6875, MAXIMUM ALLOWABLE DECARBURIZATION 0.003
- 3  $0.025 \sqrt[125]{\frac{64}{M}}$  BEFORE 2,  $\sqrt[125]{\frac{64}{M}}$  AFTER 2
- 4 BREAK ALL SHARP EDGES 0.005-0.015
- 5 i) FLUORESCENT MAGNETIC PARTICLE INSPECT PER ASTM E1444  
ii) INSPECT BEFORE AND AFTER MARKING ① - ⑩
- 6 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM ROCKWELL HARDNESS C TEST PER ASTM A370 AT NOTED LOCATION
- 7 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1
- ① - ⑩ i) MARK BEFORE 2  
ii) FOR COUPONS S1B-01 TO S1B-04: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS  
iii) FOR COUPONS S1B-05 TO S1B-16: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE II REQUIREMENTS

ALGLE PROGRAM		TITLE COUPON	DRAWING NUMBER S1B	REVISION C	DIMENSIONS ALL DIMENSIONS IN INCHES	TOLERANCES UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	DRAWN JOHN COATES
DPM EVALUATION		MATERIAL 4340 PER AMS 6415	DATE 3/9/01	SHEET 1 OF 3	SCALE NOT TO SCALE		CHECKED FRANK ZUECH

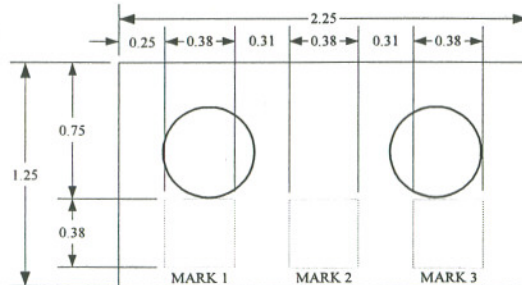
**TABLE I: DATA MATRIX™ OPTIMIZATION**

- ① – ⑩ i) AT LEAST ONE COUPON MUST CONTAIN THE MINIMUM NUMBER OF MARKS  
 ii) FOR THE MINIMUM NUMBER OF MARKS, USE DIFFERENT DPM PROCESS CONTROLS
- ① DOT PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ② LASERSHOT™ PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ③ MICRO-MILL A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ④ LASER BOND A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑤ LASER ETCH A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑥ GAS ASSIST LASER ETCH (GALE) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑦ LASER ENGRAVE A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑨ VIBRA-ETCH A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
  - ⑩ IMPRESSION STAMP A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***




**DETAIL I.B\***



**MARK DATA**

①	XXXXXXXXXX
②	XXXXXXXXXX
③	XXXXXXXXXX
④	XXXXXXXXXX
⑤	XXXXXXXXXX
⑥	XXXXXXXXXX
⑦	XXXXXXXXXX
⑧	XXXXXXXXXX
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

<b>ALGLE PROGRAM</b>		<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S1B	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
<b>DPM EVALUATION</b>		<b>MATERIAL</b> 4340 PER AMS 6415	<b>DATE</b> 3/9/01	<b>SHEET</b> 2 OF 3	<b>SCALE</b> NOT TO SCALE		<b>CHECKED</b> FRANK ZUECH



Laser etching can be safely used in safety critical applications to mark coatings applied to substrates. The process, known in the industry as *Coat and Mark*, has been successfully demonstrated on materials used to coat aircraft aluminum surfaces and external aircraft engine components subjected to temperatures up to 2000 degrees Fahrenheit.



**Figure 6 - Typical Nd:YAG Laser Marking Station**

#### 4.6 Laser Engraving

Laser engraving involves more heat than laser etching and results in the removal of substrate material through vaporization. This technique produces a deep light marking similar to a deep electro-chemical etch marking. The major advantage of this laser marking technique is speed, because it is the quickest laser marking that can be produced. The high contrast obtained by laser coloring or etching, cannot be obtained by laser engraving because the discolored material is vaporized and ejected during the marking process. Although this method appears to be the most vigorous laser marking technique, it generally produces less damage to the substrate than laser etching. However, because it can produce micro cracking in some materials, its use in safety critical applications should be studied by a metallurgist prior to use. Like laser etching,

direct laser engraving can be easily determined by touch and low power microscope (10X) magnification.

Laser engraving is acceptable for use in safety critical applications when used in conjunction with a Coat and Remove process. The Coat and Remove process involves the coating of a part with a media of contrasting color that is subsequently removed to expose the underlying material. The marking is as resilient as the surface coating used in the process.

#### 4.7 Gas Assisted Laser Etch (GALE)

Ambient environment laser marking often results in a limited degree of contrast between the engraved mark and the background on which it is placed. This can limit the speed of the mark and the number of different materials that can be marked. The gas-assisted laser etch (GALE) technique can be used to mark an object in the presence of a selected gaseous environment, thus enhancing contrast and increasing readability. The mark is made using low power settings, enabling the mark to be made with minimal laser interaction with the target material. GALE accomplishes this by the use of an assist gas that reacts with the material under the influence of the laser energy to produce a reactant that is a different reflective color from the background. The assist gases might be reducing, oxidizing or even inert, their selection being dependent upon the target material.

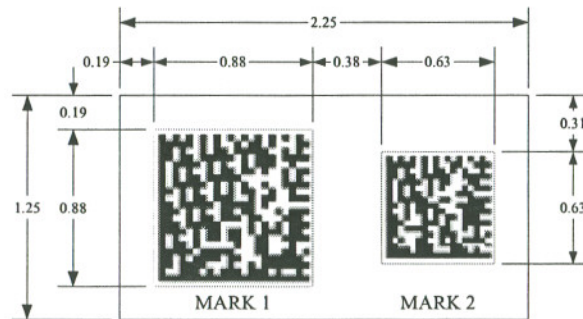
A contrasting surface results at the coincident point of the laser, the gas and the material, producing a high contrast, readable mark created in a controlled environment. Tests performed at the University of Tennessee Space Institute have demonstrated that the process should be safe for use in most aerospace marking applications.



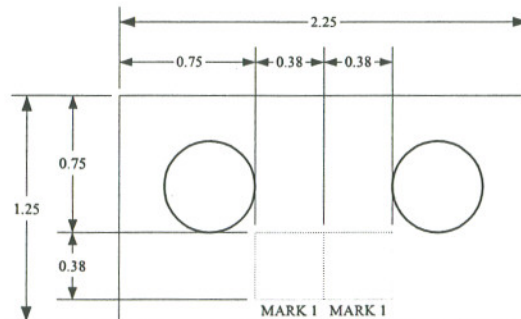
**TABLE II: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL II.A\***




**DETAIL II.B\***

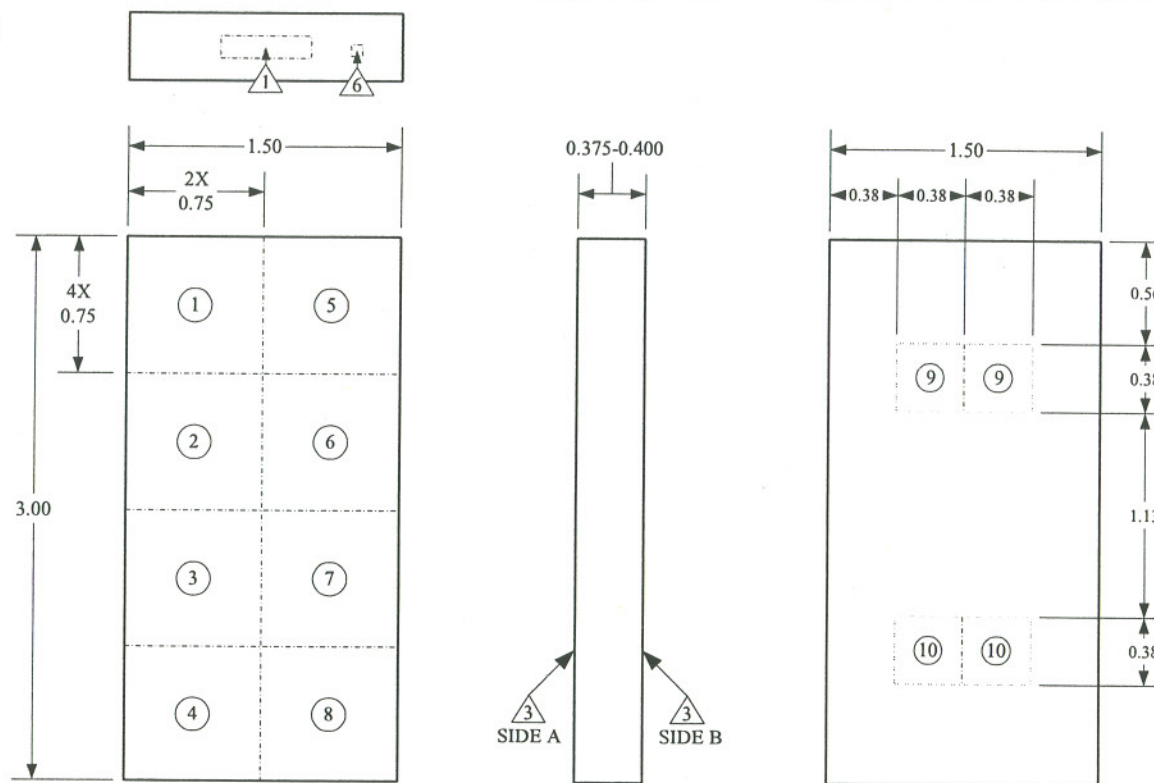


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③	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX3
④	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX4
⑤	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX5	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX5
⑥	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX6
⑦	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER	NONE
⑩	ALPHANUMERIC CHARACTER	NONE

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING


<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S1B	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
						<b>CHECKED</b> FRANK ZUECH
<b>DPM EVALUATION</b>	<b>MATERIAL</b> 4340 PER AMS 6415	<b>DATE</b> 3/9/01	<b>SHEET</b> 3 OF 3	<b>SCALE</b> NOT TO SCALE		

# COUPON



## NOTES

- 1 SERIALIZE THE COUPONS S2B-01 TO S2B-06 AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP
- 2 HEAT TREAT AND PROCESS TO 260-280 KSI ULTIMATE TENSILE STRENGTH PER AMS-H-6875, MAXIMUM ALLOWABLE DECARBURIZATION 0.003
- 3  $0.025\sqrt{\frac{125}{64}M}$  BEFORE 2,  $0.025\sqrt{\frac{125}{64}M}$  AFTER 2
- 4 BREAK ALL SHARP EDGES 0.005-0.015
- 5 i) FLUORESCENT MAGNETIC PARTICLE INSPECT PER ASTM E1444  
ii) INSPECT BEFORE AND AFTER MARKING ① - ⑩
- 6 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM ROCKWELL HARDNESS C TEST PER ASTM A370 AT NOTED LOCATION
- 7 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1
- ① - ⑩ i) MARK BEFORE 2  
ii) FOR COUPONS S2B-01 TO S2B-06: MARK WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS

<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S2B	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
						<b>CHECKED</b> FRANK ZUECH

DPM EVALUATION

**MATERIAL** 4340  
PER AMS 6415

**DATE**  
3/9/01

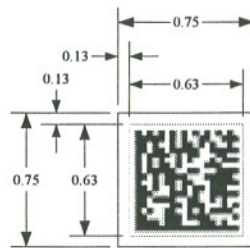
**SHEET**  
1 OF 2

**SCALE**  
NOT TO SCALE

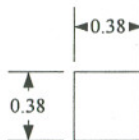
**TABLE I: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***




**DETAIL I.B\***



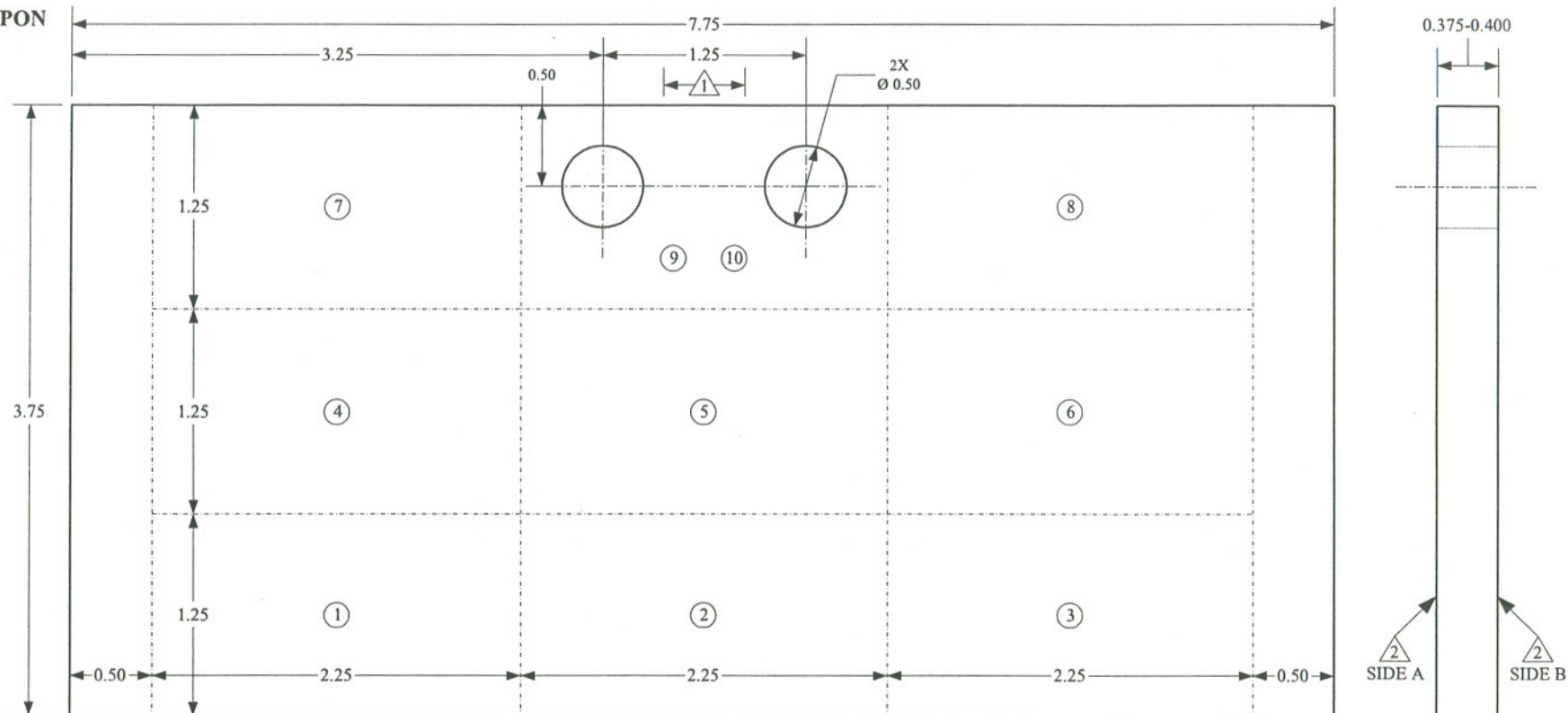
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⑥	XXXXXXXXXXXXXXXXXXXX6
⑦	XXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> S2B	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
				<b>SCALE</b> NOT TO SCALE		<b>CHECKED</b> FRANK ZUECH



# COUPON



## NOTES



SERIALIZE THE COUPONS A1A-01 TO A1A-22 ON TOP EDGE AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP



$\frac{125}{64}$   
0.025 M

3

BREAK ALL SHARP EDGES 0.005-0.015

4

FLUORESCENT PENETRANT INSPECT PER ASTM E1417

5

FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM CONDUCTIVITY TESTS PER MIL-STD-1537

6

FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1

① - ⑩

i) FOR COUPONS A1A-01 TO A1A-04: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS  
ii) FOR COUPONS A1A-05 TO A1A-16: MARK SIDE A WITH DATA MATRIX™ SYMBOLS PER TABLE II REQUIREMENTS

ALGLE  
PROGRAM



TITLE  
COUPON

DRAWING NUMBER  
A1A

REVISION  
C

DIMENSIONS  
ALL DIMENSIONS IN INCHES

TOLERANCES  
UNLESS OTHERWISE NOTED  
X.X = ± 0.1  
X.XX = ± 0.05  
ANGLES = ± 0.5°

DRAWN  
JOHN COATES

DPM EVALUATION

MATERIAL 7075-T7351  
PER AMS 4078 (0.5 INCH PLATE)

DATE  
3/9/01

SHEET  
1 OF 3

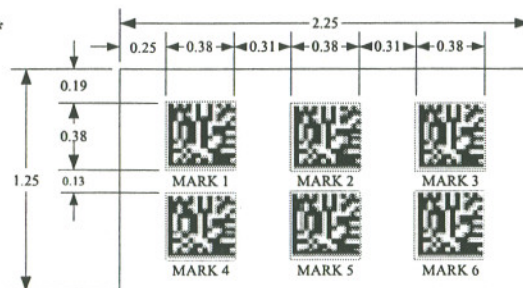
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FRANK ZUECH

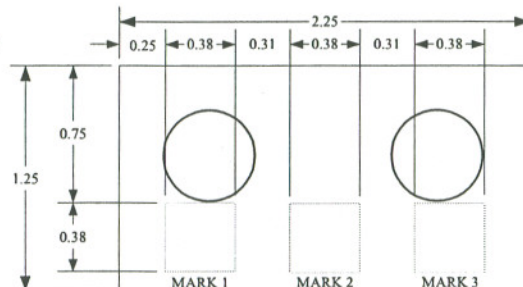
**TABLE I: DATA MATRIX™ OPTIMIZATION**

- i) AT LEAST ONE COUPON MUST CONTAIN THE MINIMUM NUMBER OF MARKS  
 ii) FOR THE MINIMUM NUMBER OF MARKS, USE DIFFERENT DPM PROCESS CONTROLS
- ① DOT PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ② LASERSHOT™ PEEN A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ③ MICRO-MILL A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ④ LASER BOND A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑤ LASER ETCH A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑥ GAS ASSIST LASER ETCH (GALE) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑦ LASER ENGRAVE A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) A MINIMUM OF 6 MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
  - ⑨ VIBRA-ETCH A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
  - ⑩ IMPRESSION STAMP A MINIMUM OF 3 MARKS IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***



**DETAIL I.B\***



**MARK DATA**

①	XXXXXXXXXX
②	XXXXXXXXXX
③	XXXXXXXXXX
④	XXXXXXXXXX
⑤	XXXXXXXXXX
⑥	XXXXXXXXXX
⑦	XXXXXXXXXX
⑧	XXXXXXXXXX
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

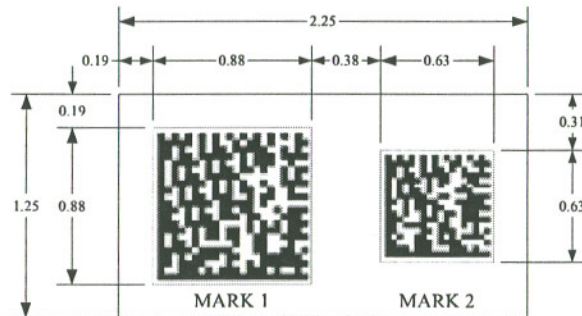
<b>ALGLE PROGRAM</b>	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> A1A	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
<b>DPM EVALUATION</b>	<b>MATERIAL</b> 7075-T7351 PER AMS 4078 (0.5 INCH PLATE)	<b>DATE</b> 3/9/01	<b>SHEET</b> 2 OF 3	<b>SCALE</b> NOT TO SCALE		<b>CHECKED</b> FRANK ZUECH



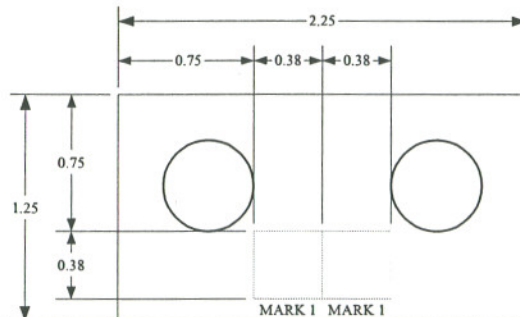
**TABLE II: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL II.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL II.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL II.A\***



**DETAIL II.B\***

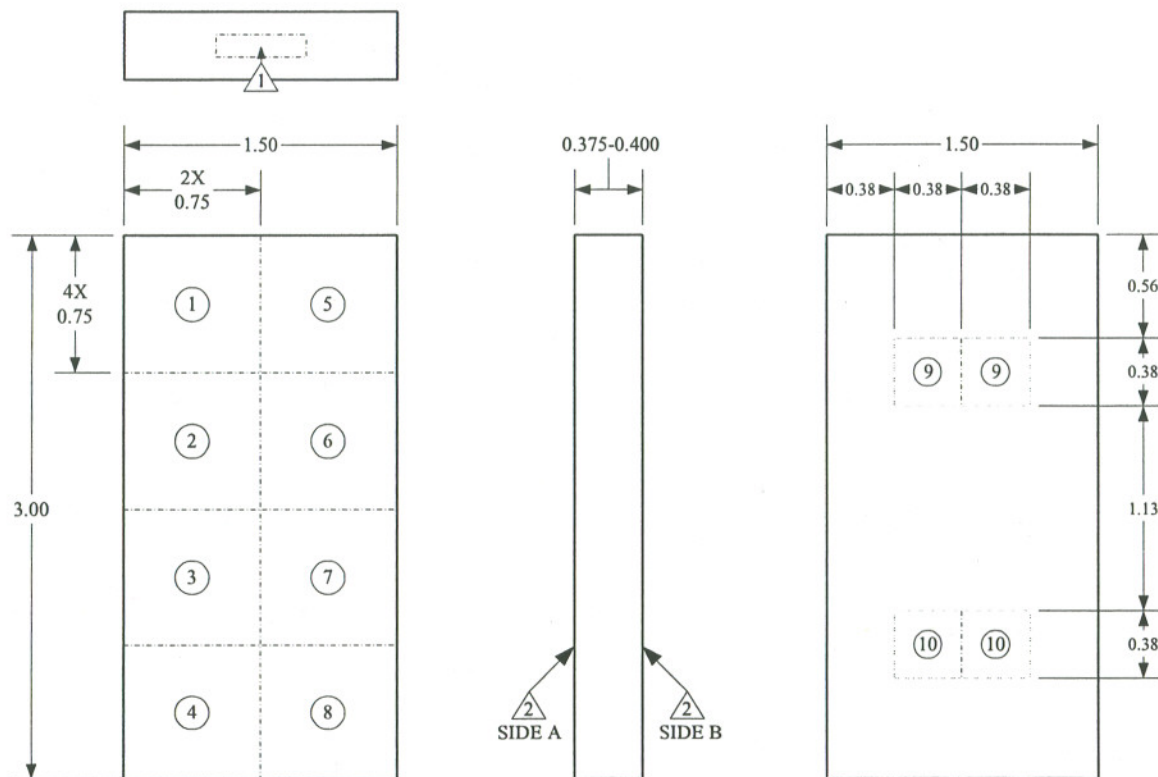


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②	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX2	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX2
③	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX3
④	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX4
⑤	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX5	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX5
⑥	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX6
⑦	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX8	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER	NONE
⑩	ALPHANUMERIC CHARACTER	NONE

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING


ALGLE PROGRAM	TITLE COUPON	DRAWING NUMBER A1A	REVISION C	DIMENSIONS ALL DIMENSIONS IN INCHES	TOLERANCES UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	DRAWN JOHN COATES
DPM EVALUATION	MATERIAL 7075-T7351 PER AMS 4078 (0.5 INCH PLATE)	DATE 3/9/01	SHEET 3 OF 3	SCALE NOT TO SCALE	CHECKED FRANK ZUECH	

# COUPON



## NOTES

- 1 SERIALIZE THE COUPONS A2A-01 TO A2A-12 AT NOTED LOCATION USING 0.25 IMPRESSION STAMP, 0.004-0.008 DEEP
- 2  $0.025 \sqrt{\frac{125}{64}} \text{ M}$
- 3 BREAK ALL SHARP EDGES 0.005-0.015
- 4 FLUORESCENT PENETRANT INSPECT PER ASTM E1417
- 5 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM CONDUCTIVITY TESTS PER MIL-STD-1537
- 6 FOR COUPONS WITH EVEN SERIAL NUMBERS: PERFORM SURFACE ROUGHNESS MEASUREMENT PER ASME B46.1
- ① - ⑩ FOR COUPONS A2A-01 TO A2A-06: MARK WITH DATA MATRIX™ SYMBOLS PER TABLE I REQUIREMENTS

<b>ALGLE PROGRAM</b> 	<b>TITLE</b> COUPON	<b>DRAWING NUMBER</b> A2A	<b>REVISION</b> C	<b>DIMENSIONS</b> ALL DIMENSIONS IN INCHES	<b>TOLERANCES</b> UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	<b>DRAWN</b> JOHN COATES
						<b>CHECKED</b> FRANK ZUECH

DPM EVALUATION

**MATERIAL** 7075-T7351  
PER AMS 4078 (0.5 INCH PLATE)

**DATE**  
3/9/01

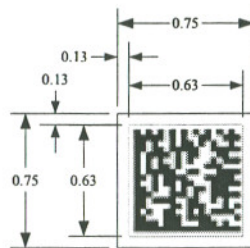
**SHEET**  
1 OF 2

**SCALE**  
NOT TO SCALE

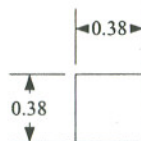
**TABLE I: DATA MATRIX™ REQUIREMENTS**

- ① DOT PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ② LASERSHOT™ PEEN MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ③ MICRO-MILL MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.024-0.032 DEEP
- ④ LASER BOND MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑤ LASER ETCH MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑥ GAS ASSIST LASER ETCH (GALE) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑦ LASER ENGRAVE MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027), 0.008-0.016 DEEP
- ⑧ LASER INDUCE SURFACE IMPROVEMENT (LISI) MARKS IN DETAIL I.A PER NASA-HDBK-6003 (P027)
- ⑨ VIBRA-ETCH MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)
- ⑩ IMPRESSION STAMP MARK IN DETAIL I.B PER OO-ALC/LITP PROCEDURE (NOT A MACHINE READABLE MARK)

**DETAIL I.A\***



**DETAIL I.B\***



MARK DATA	
①	XXXXXXXXXXXXXXXXXXXXX1
②	XXXXXXXXXXXXXXXXXXXXX2
③	XXXXXXXXXXXXXXXXXXXXX3
④	XXXXXXXXXXXXXXXXXXXXX4
⑤	XXXXXXXXXXXXXXXXXXXXX5
⑥	XXXXXXXXXXXXXXXXXXXXX6
⑦	XXXXXXXXXXXXXXXXXXXXX7
⑧	XXXXXXXXXXXXXXXXXXXXX8
⑨	ALPHANUMERIC CHARACTER
⑩	ALPHANUMERIC CHARACTER

\*DIMENSIONS INDICATE THE MAXIMUM ALLOWABLE AREA FOR MARKING

ALGLE PROGRAM	TITLE COUPON	DRAWING NUMBER A2A	REVISION C	DIMENSIONS ALL DIMENSIONS IN INCHES	TOLERANCES UNLESS OTHERWISE NOTED X.X = ± 0.1 X.XX = ± 0.05 ANGLES = ± 0.5°	DRAWN JOHN COATES
DPM EVALUATION	MATERIAL 7075-T7351 PER AMS 4078 (0.5 INCH PLATE)	DATE 3/9/01	SHEET 2 OF 2	SCALE NOT TO SCALE		CHECKED FRANK ZUECH